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ABSTRACT

This experiment compared retarded and normal subjects at different developmental levels on visual (V) and haptic (H) matching tasks. Systematic observations of variables known to have developmentally linked effects on accuracy, including stimulus complexity and haptic exploratory search style, were made. Seventeen mentally retarded subjects, with chronological ages (CAs) of about 12 years and mental ages (MAs) of either about 5 years or 7.5 years, and 23 normal IQ subjects, with the CAs of about 5, 7.5 or 12 years, matched for identity three sets of stimuli of progressively increasing unfamiliarity. Each child was given four series of 10 matching triads (V-V, V-H, H-V, and H-H) for each stimulus set. Videotape recordings were made of hand movements during haptic exploration and later scored for the occurrence of specific search styles. It was found that accuracy improved with increasing MA, regardless of whether subjects were mentally retarded or normal IQ. Developmental differences were more apparent as stimulus complexity increased. Higher MA subjects showed more active and organized haptic search of more complex stimuli than did lower MA subjects. Sensory modality effects occurred as MA increased but were dependent on stimulus complexity. Mentally retarded children appeared to show developmental improvements in intersensory matching accuracy similar to those observed in normal IQ children, but performance seemed influenced by the nature of the stimulus. These improvements seemed tied to attentional variables such as haptic exploration, just as they are in normal children. (Author/BE)

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Accuracy in shape matching within and across vision and touch improves with development in normal IQ children and matching by eye is usually better than matching by hand. The pattern is less clear for mentally retarded Ss, however. To clarify the question, this experiment compared retarded and normal Ss at different developmental levels in visual and haptic matching, ,aking systematic observations of variables known to have developmentally linked effects on accuracy, including stimulus complexity and haptic exploratory search style.

Mentally retarded Ss (CA about 12 yrs.) with MAs of either about 5 yrs. or 7.5 yrs. and normal IQ Ss (CA either about 5-, 7.5-, or 12-yrs.) matched for identity three sets of stimuli of progressively increasing unfamiliarity. Each S was given four series of ten matching trials (V-V, V-H, H-V, and H-H) for each stimulus set. Videotape recordings were made of hand movements during haptic exploration and later scored for the occurrence of specific search styles.

Accuracy improved with increasing MA, regardless of whether Ss were mentally retarded or normal IQ. These differences were greater as stimulus complexity increased. Also, higher MA Ss showed more active and organized haptic search of more complex stimuli than did lower MA Ss. Modality effects occurred as MA increased, but were dependent on stimulus complexity.

Mentally retarded Ss appear to show developmental improvements in intersensory matching accuracy similar to those observed in normal IQ Ss, but performance seems influenced by the nature of the stimulus. Also, these improvements seem tied to attentional variables such as haptic exploration, just as they are in normal children.

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SUBMITTER'S SOCIAL SECURITY NUMBER: 155-30-4092

Haptic-Visual Matching of Shape by Mentally Retarded Children: Effects of Stimulus Complexity and Haptic Exploratory Activity[1]

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The literature on shape matching within and across vision and touch has clearly demonstrated developmental improvements in accuracy (cf, Abravanel, 1968; Birch and Lefford, 1963; Rose, Blank, and Bridger, 1974). Moreover, visual intramodal matching, in most cases is consistantly better than intra- or intermodal matching involving a haptic component, regardless of the child's age.

The pattern is less clear with the mentally retarded child, however. Hermelin and O'Connor (1961) reported that retarded children with IQ's of approximately 45 showed haptic matching that was superior to visual intramodal matching and superior to that of a control group of children with normal intelligence while the control children were superior in visual matching.

Most attempts to replicate Hermelin and O'Connor's results have been unsuccessful, in that the pattern of errors for the mentally retarded child was not different from normal children (cf. Jones and Robinson, 1973; Zung, 1971; Medinus & Johnson, 1966). However, confounding of developmental levels of subjects, tasks, and stimulus variables leave the issue still clouded.

The present experiment focuses on the question of MA-CA-IQ confounding by studying haptic and visual shape matching in retarded and normal children at different developmental levels while controlling for both MA and CA. At the same time, systematic observations were made of variables known to have developmentally related effects on matching accuracy including stimulus complexity and haptic exploratory search style.

The subjects were 17 non-institutionalized mentally retarded children (age range = 11 yrs., 3 mo. to 14 yrs., 8 mo., mean age = 13 yrs., 1 mo.) divided into high and low MA groups. The high MA group (n=6) had a mean IQ = 65.50, SD = 4.23, MA = 8 yrs., 6 mo., and the low MA group (n = 11), had a mean IQ = 43.81, SD = 6.80, MA = 5 yrs., 6 mo.

Also a total of 23 nursery, elementary, and junior high school children with average IQs were divided into three control groups according to CA, to correspond to the MAs of the experimental groups and their mean CA. Included were a low MA control (mean CA = 5 yrs., 0 mo., n = 8), a high MA control (mean CA = 8 yrs., 0 mo., n = 8), and a CA control (mean CA = 13 yrs., 0 mo., n =7).

Three sets of stimulus shapes were used. Each set contained ten different stimuli and each set was progressively more abstract and complex than the last. Set 1 consisted of common objects, encountered by all children in daily living and used by Mackay & MacMillan, (1968), including a comb, orange, pencil, coffee cup, small "golden book", hair brush, child's shoe, fork, spoon, and key. Clearly, object size and shape varied widely.

Set II consisted of standards 1 through 7, 9, 10, and 11 from the Gibson letter-like form set shown in Fig. 1 (Gibson, E., Gibson, J., Pick & Osser, p. 898). Set III consisted of the free-form solids set created by J. Gibson (1966), shown in Fig 2, consisting of smooth sculpted complex three-dimensional forms.

Each subject was given four series of 10 matching trials (H-H, H-V, V-H, and V-V) for each stimulus set, with each trial involving exploration first a standard, then two comparison stimuli, one of which was the same as the standard. Each child was tested in two sessions of approximately 35 min. each.

For visual matching, stimuli were presented on a "lookie-feelie" box stage with exposure time controlled by a curtain. For haptic matching, the subject placed the hands through holes in the box front and explored inside the box. Exploration time was limited to fifteen seconds per stimulus, although no subject required the full time on any trial.

Videotape recordings were made of hand movements. Each child's trials were scored by two coders (reliability 73.5%) for the occurrence of any of a number of pre-defined search styles, including global search (independent use of the fingers to simultaneously explore many features of the stimulus); detailed search (coordinated use of two or more fingers to examine one stimulus feature at a time; palmer search (pressing the palm downward against the top surface of the stimulus); kinesthetic measuring (spreading the fingers out and aligning them around the perimeter of the shape successively); patting (using two or three fingers to simply repeatedly pat the stimulus surface without any differential finger movement); and static touching (laying a few or more fingers on the stimulus with no active movement). An "unclassifiable" category was also included.

The error data are shown in Table 1.

Accuracy in the present study depended generally upon both stimulus complexity, modality and mental age. Judgments improved with increasing MA, regardless of whether subjects were mentally retarded or of average IQ., and the more complex the stimulus, the more developmentally advanced the child in order for accurate performance to occur. Modality effects did occur, but always involved differences between V-V matching and all other modality conditions. Also, while V-V superiority increased with increasing MA and stimulus complexity, this modality effect was also infludenced by the child's intellectual capacity (regardless of stimulus, average IQ subjects were more accurate in V-V matching then mentally retarded subjects with similar MAs).

Analysis of Scanning Data

The percentages of subjects' judgments in which specific scanning styles occurred are shown in Figure 1.

Insert Figure 1 about here

The occurrence of different styles depended on the stimulus and the developmental status of the subjects, both in terms of MA, and IQ. When exploring common objects with the more complex stimuli subjects most often used only global palmer search and tracing also occurred and only minor differences occurred between MR Ss and their MA controls. Also most developmental changes occurred between MA = 5 years, and MA = 8 years.

These findings also seem to show that as developmental level increased, the use of more active search strategies increased. Of the seven search strategies we observed, three involved considerable active movement (global and detailed search, and tracing). The remaining styles involved much less active finger and hand movements, tending toward more static contact with the stimulus (kinesthetic measuring, palmer search, patting, and static touching). A breakdown of scanning along these lines is summarized in Fig. 4.

Insert Figure 2 about here

An analysis of these differences showed (1) when subjects explore common objects, no differences as a function of MA were noted between active and passive strategies. However, for both letter-like forms and free forms, the frequency of active strategies increased ($p < .028$ for both comparisons), and passive strategies decreased ($p < .025$ for both comparisons) as MA increased. Also, retarded subjects did not differ from their MA controls for either common objects or letter-like forms. But for free forms, low MA retarded children showed significantly fewer active strategies ($p < .041$) and high MA subjects, fewer active strategies ($p < .019$) and more passive strategies ($p < .04$) than their respective MA controls.

Our initial analysis of the individual scanning styles also suggested that as stimulus complexity increased, the number of strategies used per judgment also increased. These data, summarized in Table 2, showed that significant increases

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Insert Table 2 about here

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in the number of strategies per trial occurred for all MA and IQ groups as stimulus complexity increased, ($p < .01$). Also, a marginally significantly greater number of strategies were used by average IQ children in judging the free-form solids compared to mentally retarded children, $p = .056$.

Just as with children of average IQ, performance in cross modal and intramodal matching tasks by mentally retarded children seems to depend on task factors, developmental level, stimulus factors, and response characteristics. These factors must be taken into consideration when comparing results across experiments. The present study points to three factors which seem critical to the process.

1. The nature of the stimulus. Our results show that overall matching accuracy, as well as the presence or absence of modality effects, is influenced by the stimulus. Moreover, there was an interaction between the stimulus and the hand movements, and between the hand movements and intellectual status of subjects, and the stimulus. These findings parallel Abravanel's (1968) results for normal children roughly within the CA range studied in our series, suggesting that the pattern of stimulus effects we report for retarded children is quantitatively similar to children who are not retarded.

2. Developmental level of the subjects. In general, the present study shows that mentally retarded children appear to show developmental improvements in intersensory and intrasensory shape matching accuracy that parallel those observed in children with similar MAs, and that the pattern of improvement over age generally found in children with average intelligence also occurs in mentally retarded children.

Our data also indicate one departure from this general pattern. Mentally retarded subjects, regardless of MA, performed V-V matching less accurately than their MA controls. This finding suggests that mentally retarded children may

make less effective use of visually gathered information about shape, a prediction of Hermelin & O'Connor (1963).

3. The nature of haptic search. All dependent measures of haptic exploratory search behavior showed remarkable developmental shifts toward use of a greater number of more active search styles with increasing MA of the subjects. Also, aside from some minor exceptions, the same pattern seemed to occur for both retarded and non-retarded subjects.

The progression of difficulty in the stimuli also led to different patterns of search with parallel developmental trends.

The findings of the present study demonstrate a correlation between haptic exploratory search style and accuracy of intramodal and intermodal shape matching for all subjects regardless of their developmental status.

Our data also suggest that specific components of the attentional process, such as exploratory search behavior, as they interact with task and stimulus factors, may provide a fruitful means of clarifying the nature of perceptual deficits repeatedly observed in the mentally retarded child.

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Table 1

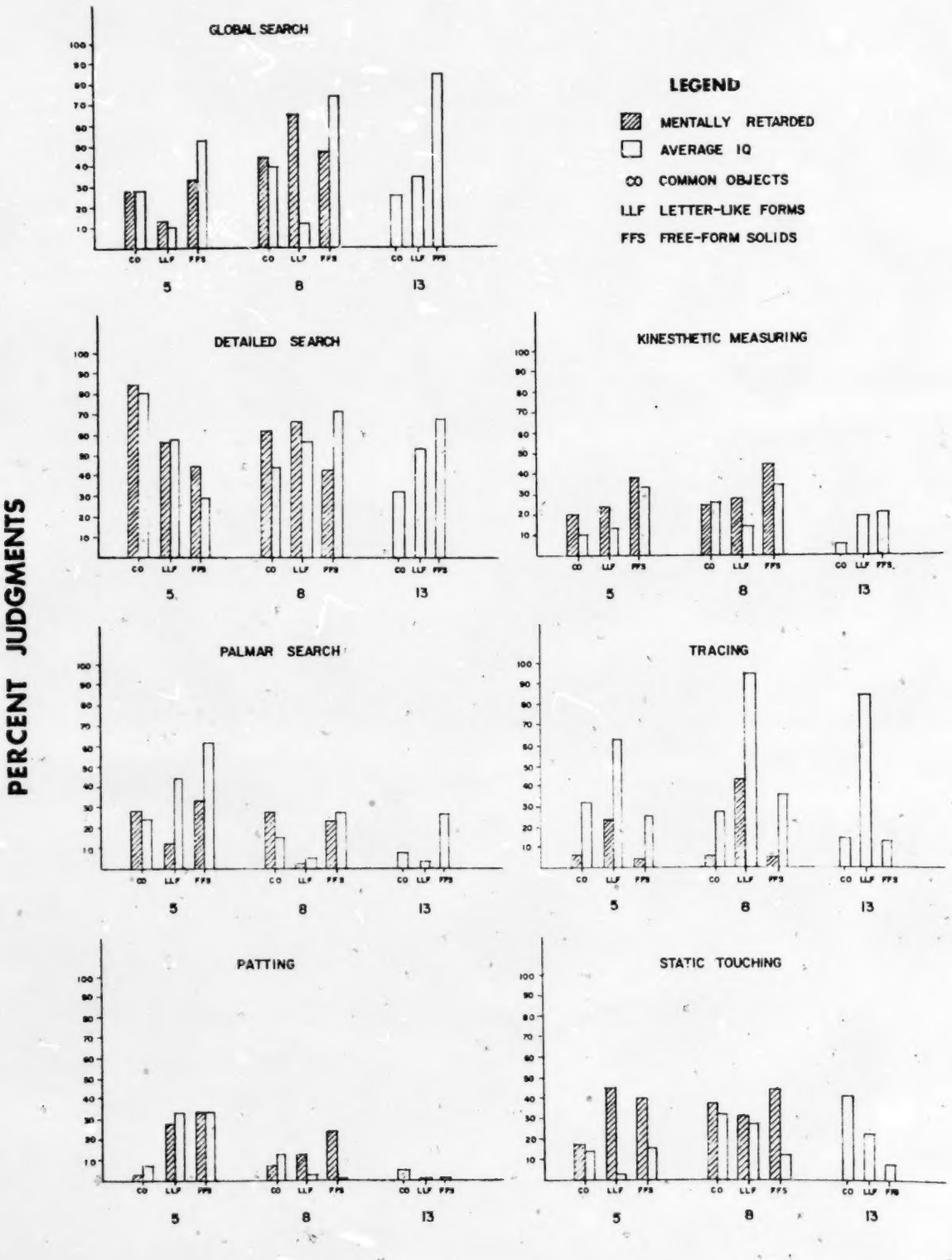
Mean Matching Errors

Group	Common Objects				Letter-Like Forms				Free Form Solids			
	V-V	V-H	H-V	H-H	V-V	V-H	H-V	H-H	V-V	V-H	H-V	H-H
Mentally Retarded (CA = 13 years)												
Low MA (5 years)	.45	.72	.54	1.5	1.8	4.1	4.5	3.8	4.7	4.9	4.1	4.7
High MA (8 years)	.16	.33	.33	.00	.50	1.3	.66	1.3	3.1	4.0	2.6	3.6
Normal Intelligence (CA = MA)												
MA = 5 yrs.	.12	.51	.37	.75	1.0	5.0	4.1	4.5	4.7	4.8	5.6	5.1
MA = 8 yrs.	.00	.00	.00	.00	.00	1.0	1.0	1.5	1.5	2.7	3.6	3.6
MA = 13 yrs.	.00	.00	.00	.00	.00	.42	.14	.85	.14	1.8	2.7	2.5

Table 2

Number of Scanning Strategies Per Judgment

Group	Stimulus		
Mentally Retarded (CA= 13 yrs.)	Common Objects	Letter-Like Forms	Free Form Solids
Low MA (5 yrs.)	1.89	2.13	2.22
High MA (8 yrs.)	2.01	2.56	2.26
Average Intelligence (CA = MA)			
MA = 5 yrs.	1.97	2.39	2.57
MA = 8 yrs.	1.69	2.17	2.57
MA = 13 yrs.	1.40	2.20	2.24


GLOBAL SEARCH
DETAILED SEARCH
KINESTHETIC MEASURING
PALMAR SEARCH
TRACING
PATTING
STATIC TOUCHING
LEGEND
MENTALLY RETARDED
AVERAGE IQ
CO COMMON OBJECTS
LLF LETTER-LIKE FORMS
FFS FREE-FORM SOLIDS
PERCENT JUDGMENTS
MENTAL AGE (YRS)
5
8
13

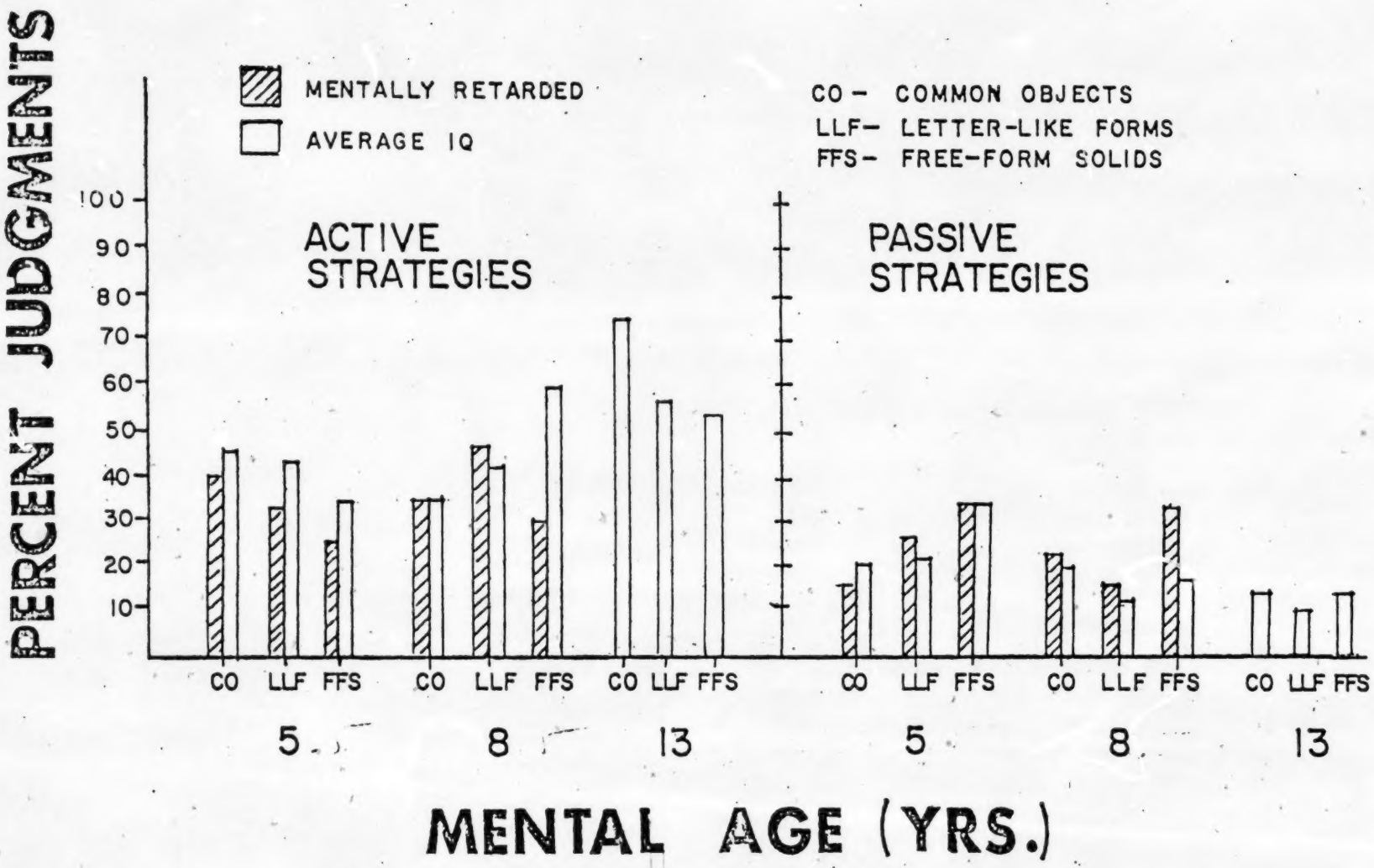

MENTALLY RETARDED
AVERAGE IQ
CO – COMMON OBJECTS
LLF– LETTER-LIKE FORMS
FFS– FREE-FORM SOLIDS
PERCENT JUDGMENTS
100
90
80
70
60
50
40
30
20
10
ACTIVE STRATEGIES
PASSIVE STRATEGIES
CO LLF FFS CO LLF FFS CO LLF FFS CO LLF FFS CO LLF FFS CO LLF FFS
5
8
13
5
8
13
MENTAL AGE (YRS.)

fig. 2